

Diversity and abundance of insects at industrial plantation forest and natural forest ecosystems in Siak, Riau Province

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ABSTRACT

The objective of research is to find out the differences and similarities of insect diversity, abundance and composition between in industrial plantation forest (HTI) and natural forest (Arboretum) ecosystems. Field research was carried out in the Rasau Kuning area, Perawang Barat Regency, Riau Province, while specimens identification conducted at LIPI Biology Research Center Laboratory in February - March 2019. Line transect sampling technique and fluorescent light traps were used as methods for collecting insects from both two different ecosystems with three replications. The results found five order of insects i.e. Lepidoptera, Hemiptera, Coleoptera, Orthoptera, and Hymenoptera which consisting of 35 species in plantation forest ecosystem, and 26 species in natural forest ecosystem where both ecosystems dominated by Lepidoptera. Statistical analysis of research results show that two average insects species diversity index within both plantation forest (HTI) and natural forest (Arboretum) ecosystems is not different ($t = 1,419$; $p > 0,05$). The similarity index found very similar (23,56%) between both ecosystems. Predatory insects which was found in this study is *Sycanus* sp. (Hemiptera: Reduviidae) from the order of Lepidoptera.

ABSTRAK

Penelitian ini bertujuan untuk mengungkapkan perbedaan dan kesamaan keanekaragaman jenis, kelimpahan, dan komposisi jenis serangga antara di ekosistem hutan tanaman industri (HTI) dengan ekosistem hutan alam (Arboretum). Penelitian lapang dilakukan di areal Rasau Kuning, Kabupaten Perawang Barat, Provinsi Riau, sementara identifikasi specimen dilakukan di Laboratorium Pusat Penelitian Biologi LIPI, pada bulan Februari - Maret 2019. Metode sampling line transect dan perangkap cahaya berfluoresen digunakan untuk menangkap serangga di kedua ekosistem tersebut melalui 3 kali ulangan. Hasil studi menemukan 5 ordo serangga yaitu Lepidoptera, Hemiptera, Coleoptera, Orthoptera, and Hymenoptera, dengan masing-masing 25 spesies terdapat di ekosistem hutan tanaman (HTI) dan 26 spesies di ekosistem alam (Arboretum), yang mana keduanya didominasi ordo Lepidoptera. Melalui analisis statistik, hasil penelitian menunjukkan bahwa pada kedua ekosistem tidak terlihat adanya perbedaan indeks keanekaragaman jenis ($t = 1,419$; $p > 0,05$). Begitu juga dengan indeks kesamaan menunjukan tingkat yang sangat sama (23,56%) antara kedua ekosistem tersebut. Pada kajian ini juga ditemukan spesies serangga predator yaitu *Sycanus* sp. (Hemiptera; Reduviidae) dari ordo Lepidoptera.

Keywords: Insects, diversity, similarity, abundance, plantation forest, ecosystem, predatory insects

INTRODUCTION

Every organism's activity within its community always interact with the activities of other organisms in a complex linkages and dependency that creating a stable community. Interaction between those organisms can be antagonistic, competitive, or positive as symbiotic (Untung, 2006).

The concept of biological control emerged and developed as a correction to conventional pest control policies, which are very important in the use of

pesticides. This policy results in inappropriate and excessive use of pesticides by farmers, and this method can increase production costs and cause adverse side effects on the environment and the health of farmers themselves and the community at large.

In natural forests, biological control mechanisms through natural enemies can develop naturally and can spread to industrial plantation forests, which is difficult to prove scientifically but the forest ecosystem has always had such a balance mechanism.

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Prevention action in industrial plantations with the use of clones that are resistant to pests and diseases has been done in most countries, such as the United States, Australia, Europe, South Africa and South American countries, like in Brazil where the clone of *Eucalyptus* was founded, including its hybrids that have high growth and good resistance to pests and diseases. But it must be realized that along with the development of time, pathogens or pests also adapt to their environment. Therefore, monitoring pests and diseases as a step to determine the development of pests and diseases must be carried out.

The role of insects in community is varied such as pollinators, phytophagous, and predators, and there is also a species of insect that only come temporarily in plants or plantations. Species of insects that damage trees will give a large-scale losses to attack plants.

The survey which was conducted at Rasau Kuning area, Perawang Barat, Riau, found that there was an abundance of insects that ranging from caterpillars, grasshoppers, lice and grubs, while the symptoms of damaged by caterpillars usually attacking leaves which cause different levels of damage.

The use of natural enemies is an efficient control that has the lowest impact at a cost that is not too large. With the diversity of pests found in *Eucalyptus* plantations, research to find natural enemies in *Eucalyptus* can be used as an alternative in implementing integrated pest control.

Therefore, researchers used research related to the determination of insects as a reference material of what species are found in the industrial plantation forest ecosystem (HTI) and in natural forest ecosystem (Arboretum) through analysis of the species diversity and abundance of insects.

Research questions that carried out consist of:

1. Is there any differences of insect diversity between the HTI forest and natural forest ecosystems?
2. Is there any differences of insect abundance between the HTI forest and natural forest ecosystems?
3. Is there any differences of insect similarity between the HTI forest and natural forest ecosystem?

The objective of this research is to determine differences in species diversity and abundance based on the order found and determine the level of differences in insect species based on the Sorensen similarity index both in industrial plantation forests (HTI) and natural forest (Arboretum) ecosystem. It is expected that the results of this study can provide information about pests and natural predators insects which have the potential as Biological Control of pest species.

METHODS

This research was conducted in two places. Firstly, field work carried out in Rasau Kuning area, inside the industrial plantation forest (HTI) concession of PT. Arara Abadi, Perawang, Riau Province, to collect the data and specimens of insects at industrial plantation forest (HTI) ecosystem and at natural forest ecosystem (Arboretum). Secondly, the samples of insect specimens collected then identified in LIPI Biology Research Center Laboratory. Both research activities conducted in February - March 2019.

Industrial plantation forest ecosystem in Rasau Kuning area is mostly planted with *Eucalyptus pelita* but in some places there is still an area planted with *Pinus merkusii*. (Lisnawati et al., 2014). Sampling of insects in natural forest ecosystem conducted in Arboretum Forest of PT. Arara Abadi, a secondary natural forest with the size of 173 hectare, and is dominated by Kulim trees (*Scorodocarpus borneensis*). The topography in the study area mostly flat (0-8%) to undulating (8-15%) area. The elevation variation ranging between 8 - 80 m above sea level. Climate classification in the study area according to Schmidt and Ferguson (1951) is a type of Climate A. While the air temperature in this region ranges from 26.3° - 27.8° C.

Purposive random sampling technique was used to determine sampling location in both HTI and Arboretum areas (Muslim et al., 2017). A 500 meters observation transect was made in HTI and in Arboretum. Then fluorescent light traps were installed along the Transect at intervals of 100 meters.

Florescent light traps that installed in 10 plot locations (five location in HTI and five locations in Arboretum) opened 12 hours to capture insects starting from 6 pm (afternoon) until 6 am in the next

morning. This activity was repeated until three replications at both HTI and Arboretum.

All specimens collected then it was identified until species level using electron microscopes and the insect guide book at the LIPI Biology Research Center Laboratory.

RESULTS AND DISCUSSION

From data collected found five order of insects such as Lepidoptera, Hemiptera, Coleoptera, Orthoptera, and Hymenoptera. The highest abundance is Lepidoptera and lowest are Hymenoptera and Orthoptera (Table 1.).

Table 1. Number of insect species found in industrial forest plantation and natural forest ecosystems in study area.

Ecosystem	Order	Observation		
		I	II	III
HTI (Industrial plantation forest)	Lepidoptera	69	34	41
	Hemiptera	2	1	0
	Coleoptera	4	4	5
	Orthoptera	0	1	1
	Hymenoptera	1	0	0
Arboretum (Natural forest)	Lepidoptera	63	56	66
	Hemiptera	0	0	0
	Coleoptera	0	1	1
	Orthoptera	1	1	1
	Hymenoptera	0	0	0

Table 2. Insect's diversity index at two different ecosystems in the study area. Number that followed by the same letter showing no significant difference at the test level of 5%.

Ecosystem	Diversity Index			Av. of divers. index
	Obs. I	Obs. II	Obs. III	
HTI (Industrial plantation forest)	2.400	2.953	3.005	2.786 ^a
Arboretum (Natural forest)	2.208	2.551	2.615	2.458 ^a

Statistical analysis conducted to the results of two average number of insect species in the HTI and Arboretum ecosystems showed that $t_{\text{count}} = 3.500$ (significantly different at a level 5%) α level 5%.

The average of insect diversity index for each location is shown in Table 2. The results of the statistical analysis of t against the two average insects species diversity index in HTI ecosystem and Arboretum ecosystem obtained $t_{\text{count}} = 1.419$. From the distribution list of Student (t distribution) is known $t_{\text{table}} 0.95 (4) = 2.776$. When compared the value of t_{count} with t_{table} it turns out that $t_{\text{count}} < t_{\text{table}}$, it means that the average diversity of insects in the HTI ecosystem is not significantly different from the Arboretum ecosystem at the test level of 5%.

According to Barnes et al. (1997), that endemic species are often significant contributors to regional diversity, so that there is no significant difference in insect diversity within a limited area or at the level of alpha diversity (less than one to several hundred hectares) can be categorized as not yet occurring pressure or pollution. Pressure or pollution causes the number of species to decrease while the number of individuals rises. Pollution causes the emergence of rare species and increases populations of species that are resistant to stress (Odum, 1983).

Based on species diversity and the number of species obtained, the Equitability index (Odum, 1983) was obtained, which is used to calculate the level of uniformity.

From the results of catching insects in HTI ecosystem, the insect species found is *Trichoptera aquatic* which indicated that the environment was not yet polluted because these insects could not live in habitats that were already polluted (Samways, 1994). Many found Formicidae (ants), it can also be used as an indicator of the condition of agroecosystems in an area (Peck et al., 1998; Rizali et al., 2002). Showing this result means that the industrial plantation forest (HTI) ecosystem in Rasau Kuning has not been much polluted by chemicals.

Insect diversity in the two ecosystems is categorized as moderate, this is due to the presence of bottom vegetation as ground cover that serves as a shelter for the organism. With this soil cover, soil fertility can be maintained by utilizing soil organisms, including insects. As stated by Arief (2001), most of the beneficial results of trees and shrubs are the result of the characteristics of soil fauna (Lisnawati et al., 2014).

The frequency of the presence of fauna species in a habitat indicates the presence or absence of that species in that habitat. The frequency of attendance is calculated and the proportion of the number of sample units in which a species can be found in all sample units is expressed in percent (Suin, 1997).

High frequency of presence means that the species is often found in the habitat (Suin, 1997). The greater the frequency of attendance means the more often the species is obtained. If a species is often found in a place, it means that the place is a habitat for that species. Therefore, the frequency of presence can be a clue to determine the habitat of a species. Heddy and Kumiaty (1996) mention that organism habitat is a place where an organism lives or a place where humans can find the organism.

According to Suin (1997) the frequency of attendance is often expressed by a constant. The value of a constant can be grouped into four groups, i.e. Accidental if the frequency of attendance is 0-25%, the constant accessory is 25-50%, the constant type is 50-75% and the absolute type if the constant are more than 75%.

Some species of insects whose frequency of presence or constant reaches the absolute level of observations I, II and III in the HTI ecosystem are *Bocchoris insperpasalis* (Lepidoptera: Pyralidae) and *Xantomelaena* sp. (Lepidoptera: Pyralidae). While in Arboretum ecosystem whose frequency of presence or constant reaches absolute levels from observations I, II and III are *Tanaorhinus rafflesi* (Lepidoptera: Geometridae).

Based on the description above it is known that there are no insect species whose level of presence reaches absolute levels at the two locations observed.

The types of insects whose level of presence reaches an absolute level in the industrial plantation forest (HTI) ecosystem are included in the group of beneficial insects as predators (predators for others) so that a balance is reached in the ecosystem.

According to Suin (1997) The highest similarity index that can be achieved between the two habitats compared is 100%, that is, if both habitats live the same species of fauna. Magurran (2004) states that the similarity index >75% means most similar, 50 - 75% similar, 25 - 50% are not similar and <25% are very not similar.

From the research results, the average index of insect species similarity in the HTI Forest with Arboretum is 23.56%, less than 25%, which is

categorized as very not similar.

The existence of this dissimilarity is caused by differences in biotic factors, namely the types of plants that exist as staple plants and undergrowth under forest stands and physical and chemical factors, such as air temperature, soil temperature, humidity, organic content and soil acidity (pH).

With the very low index of insect species similarity between HTI Forest and Arboretum, there has been a shift in species occupying the area following the changes in ecosystems.

Predator insects are one of the pest insect controllers that have the potential to be used as natural enemies of pest insects because they are able to prey on insect pests quite a lot at a time. Predatory insects can suppress the development and population of pest insects so that damage caused by pest insects can be reduced in other words large yield losses can be avoided because it will not exceed the economic threshold value of an agricultural product.

Predatory insects found in this study i.e. *Sycanus* sp. (Hemiptera: Reduviidae), it is a predator insect which is quite potential to be used in biological control of pest insects, especially from the order of Lepidoptera naturally. The spread of ladybug predators *Sycanus* sp. is only found in the HTI ecosystem. The number of *Sycanus* sp. found in the first observation was 2, then in the second observation was 1, while in the third observation was not found.

Sycanus sp. preyed on insects by jabbing the stylet into the soft parts of the insect's body parts, after which the captured insects would soon be paralyzed due to toxins released through stylet. *Sycanus* sp. can be a virus vector that is toxic to insect pests. One of virus that is spread i.e. Nuclear Polyhedrosis Virus (NPV). Predator in the research sites supported by the planting of beneficial plant that is *Tumera* sp. which is a source of nectar for added feed besides pest larva.

CONCLUSION

1. There is no differences in insect species diversity in the industrial plantation forest and natural forest ecosystems.
2. There is no difference in species abundance based on the order found in the industrial plantation forest and natural forest ecosystems which is dominated by the Lepidoptera order.
3. There is similarity in composition of insect species based on the Sorensen similarity index

between each industrial plantation forest and natural forest ecosystems.

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